

A.VINOTH KUMAR. DGD., M.Sc., M.Phil., Ph.D (Botany)

**Bio
Botany**

UNIT VII: Genetics
Chromosomal Basis of Inheritance

**12th
Std**

(Over all the 2 & 3 Marks questions)

1. Explain the chromosomal theory of inheritance?

- **Sutton and Boveri (1903)** independently proposed the chromosome theory of inheritance.
- Sutton united the knowledge of chromosomal segregation with Mendelian principles and called it chromosomal theory of inheritance.

2. List out the Salient features of the Chromosomal theory of inheritance?

- Somatic cells of organisms are derived from the zygote by repeated cell division (mitosis). These consist of two identical sets of chromosomes. One set is received from female parent (maternal) and the other from male parent (paternal). These two chromosomes constitute the homologous pair.
- Chromosomes retain their structural uniqueness and individuality throughout the life cycle of an organism.
- Each chromosome carries specific determiners or Mendelian factors which are now termed as genes.
- The behaviour of chromosomes during the gamete formation (meiosis) provides evidence to the fact that genes or factors are located on chromosomes.

3. Explain the linked and unlinked genes?

- Genes located close together on the same chromosome and inherited together are called **linked genes**.
- The two genes that are sufficiently far apart on the same chromosome are called **unlinked genes or syntenic genes**.

4. Explain the Coupling and Repulsion theory?

- The two dominant alleles or recessive alleles occur in the same homologous chromosomes, tend to inherit together into same gamete are called **coupling or cis configuration**.

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➤ If dominant or recessive alleles are present on two different, but homologous chromosomes they inherit apart into different gamete are called **repulsion or *trans* configuration**.

5. Short notes on Complete and Incomplete Linkage?

➤ If two linked genes are sufficiently apart, the chances of their separation are possible. As a result, parental and non-parental combinations are observed. The linked genes exhibit some crossing over. This phenomenon is called **incomplete linkage**. This was observed in maize. It was reported by **Hutchinson**.

➤ If the chances of separation of two linked genes are not possible those genes always remain together as a result, only parental combinations are observed. The linked genes are located very close together on the same chromosome such genes do not exhibit crossing over. This phenomenon is called **complete linkage**. It is rare but has been reported in male *Drosophila*.

6. Explain the types of synapsis or syndesis?

- **Procentric synapsis:** Pairing starts from middle of the chromosome.
- **Proterminal synapsis:** Pairing starts from the telomeres.
- **Random synapsis:** Pairing may start from anywhere.

7. What is the tetrad stage?

Each homologous chromosome of a bivalent begin to form two identical sister chromatids, which remain held together by a centromere.

At this stage each bivalent has four chromatids. This stage is called **tetrad stage**.

8. Explain the Types of Crossing Over?

Depending upon the number of chiasmata formed crossing over may be classified into **three** types.

Single cross over: Formation of single chiasma and involves only two chromatids out of four.

Double cross over: Formation of two chiasmata and involves two or three or all four strands

Multiple cross over: Formation of more than two chiasmata and crossing over frequency is extremely low.

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9. What is the Recombination?

Crossing over results in the formation of new combination of characters in an organism called recombinants.

In this, segments of DNA are broken and recombined to produce new combinations of alleles. This process is called **Recombination**.

10. List out the Importance of Crossing Over?

Crossing over occurs in all organisms like bacteria, yeast, fungi, higher plants and animals. Its importance is

- Exchange of segments leads to new gene combinations which plays an important role in evolution.
- Studies of crossing over reveal that genes are arranged linearly on the chromosomes.
- Genetic maps are made based on the frequency of crossing over.
- Crossing over helps to understand the nature and mechanism of gene action.
- If a useful new combination is formed it can be used in plant breeding.

11. What are the steps involved in DNA Recombination?

It was first proposed by **Robin Holliday** in 1964.

It involves several steps.

- Homologous DNA molecules are paired side by side with their duplicated copies of DNAs
- One strand of both DNAs cut in one place by the enzyme **endonuclease**.
- The cut strands cross and join the homologous strands forming the **Holliday structure** or **Holliday junction**.
- The Holliday junction migrates away from the original site, a process called **branch migration**, as a result heteroduplex region is formed.
- DNA strands may cut along through the vertical (V) line or horizontal (H) line.
- The vertical cut will result in heteroduplexes with recombinants.
- The horizontal cut will result in heteroduplex with non-recombinants.

12. Explain the Genetic mapping?

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- Genes are present in a linear order along the chromosome.
- They are present in a specific location called **locus** (plural: loci).
- The diagrammatic representation of position of genes and related distances between the adjacent genes is called **genetic mapping**.

13. List out the Uses of genetic mapping?

- ✓ It is used to determine gene order, identify the locus of a gene and calculate the distances between genes.
- ✓ They are useful in predicting results of dihybrid and trihybrid crosses.
- ✓ It allows the geneticists to understand the overall genetic complexity of particular organism.

14. What is the Multiple alleles?

A given phenotypic trait of an individual depends on a single pair of genes, each of which occupies a specific position called the locus on homologous chromosome.

When any of the three or more allelic forms of a gene occupy the same locus in a given pair of homologous chromosomes, they are said to be called **multiple alleles**.

15. What are the Characteristics of multiple alleles?

- Multiple alleles of a series always occupy the same locus in the homologous chromosome. Therefore, no crossing over occurs within the alleles of a series.
- Multiple alleles are always responsible for the same character.
- The wild type alleles of a series exhibit dominant character whereas mutant type will influence dominance or an intermediate phenotypic effect.
- When any two of the mutant multiple alleles are crossed the phenotype is always mutant type and not the wild type.

16. Explain the mutation and mutagens?

Genetic variation among individuals provides the raw material for the ultimate source of evolutionary changes.

Mutation and recombination are the two major processes responsible for genetic variation.

A sudden change in the genetic material of an organisms is called **mutation**.

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The term mutation was introduced by **Hugo de Vries** (1901).

Agents which are responsible for mutation are called **mutagens**.

17. Short notes on Synonymous, Missense, and Nonsense Mutation?

The mutation that changes one codon for an amino acid into another codon for that same amino acid are called **Synonymous or silent mutations**.

The mutation where the codon for one amino acid is changed into a codon for another amino acid is called **Missense or non-synonymous mutations**.

The mutations where codon for one amino acid is changed into a termination or stop codon is called **Nonsense mutation**.

18. What are the Frameshift mutations?

Mutations that result in the addition or deletion of a single base pair of DNA that changes the reading frame for the translation process as a result of which there is complete loss of normal protein structure and function are called **Frameshift mutations**.

19. Explain the Types of mutation?

Let us see the **two** general classes of gene mutation:

- Mutations affecting single base or base pair of DNA are called point mutation.
- Mutations altering the number of copies of a small repeated nucleotide sequence within a gene.

20. Define and types of Mutagenic agents?

The factors which cause genetic mutation are called **mutagenic agents or mutagens**. Mutagens are of **two** types,

Physical mutagen,

Chemical mutagen.

Muller (1927) was the first to find out physical mutagen in *Drosophila*.

21. Explain the chromosomal mutations?

The genome can also be modified on a larger scale by altering the chromosome structure or by changing the number of chromosomes in a cell.

These large-scale variations are termed as **chromosomal mutations or chromosomal aberrations**.

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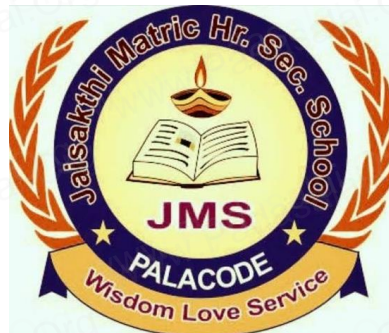
Chromosomal mutations are divided into **two** groups: changes in chromosome number and changes in chromosome structure.

22. What are the Significance of Ploidy?

- Many polyploids are more vigorous and more adaptable than diploids.
- Many ornamental plants are autotetraploids and have larger flower and longer flowering duration than diploids.
- Autopolyploids usually have increase in fresh weight due to more water content.
- Aneuploids are useful to determine the phenotypic effects of loss or gain of different chromosomes.
- Many angiosperms are allopolyploids and they play a role in an evolution of plants.

23. Define the structural chromosomal aberration?

A structural variation caused by addition or deletion of a part of chromosome leading to rearrangement of genes is called **structural chromosomal aberration**.



Notes Prepared By

Mr.A.VINOTH KUMAR. DGD, M.Sc., M.Phil., Ph.D

PG. Assistant in Botany

Jai Sakthi Matric Higher Secondary School

Palacode. Dharmapuri Dt.,

Cell No-6369060979